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ABSTRACT

The differences between edumetric and psychometric uses of tests were described and the relevance of the edumetric dimension for measuring student learning gains, especially in the context of individualized instruction involving multiple learning mode options, was clarified. Also, the procedures for edumetric reliability and validation assessment were described. The procedures were applied to two college classes, Speech Communication and World Civilizations. The results yielded strong evidence for the edumetric reliability and validity. Extremely strong evidence was provided by the reliability and validity coefficients estimated for the entire population. As part of the ongoing program of reliability and validity assessment of the Cognitive Style Mapping (CSM) items and elements, evidence was provided for the edumetric reliability and validity of CSM and various fruitful implications for further study were considered. (Author/RC)

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EDUMETRIC VALIDATION OF COGNITIVE STYLE MAP ITEMS AND ELEMENTS: I

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The abiding concern of Educational Scientists with learning necessitates the continuing development of procedures to reliably and validly measure students' learning and other gains resulting from their educational experiences. The values of Cognitive Style Mapping (CSM) have been clearly explicated including its descriptive and diagnostic uses. Because CSM accurately measures a person's learning abilities, gains in related student learning and skills should be reflected in gains in corresponding CSM items and elements. The procedures most appropriate to such a validation study involved the edumetric dimension of tests.

Psychometric & Edumetric Tests

A distinction must be made between the traditional psychometric test and the edumetric trest. The former, according to Cronbach (4, 477) began with a Darwinian stress upon the differences between individuals and proceeded to conceptualize the differences in abilities or skills between individuals. One of the consequences of this approach is that psychometric results show the measurement of individual differences in relation to a group but not necessarily the measurement of what an individual has learned. The psychometric test can be found to be reliable and valid in terms of how it reflects the consistency between individual differences. Popham (12) labeled such tests "norm-referenced." Normative comparisons result when an individual's performance is balanaced against a relevent reference group. Psychometric tests are well suited to the accepted traditioanl system of instruction or to a fixed educational environment.

It has been increasingly observed that there are serious problems involved with psychometric testing (11). Carver (1,2) pointed out the danger of generalizing the correlational results of between individual differences to within individual differences. Glaser and Nitko (6) have stated that the design of a measurement system must be preceeded by the specification of the particular instructional system. Thus it is inappropriate to use psychometric measurements as the sole means to measure the change in an individual's pattern of learning or the pattern of gain/loss in learning abilities and skills as they occur outside the traditional instructional system. Psychometric testing is difficulty to fit to a system of learning that attempts to be adaptive for the individual student.

The edumetric test is designed to measure the gain or growth of an individual's knowledge, learning skills or abilities. McClelland (11, 8) observed that "It seems wiser...to select tests...that are valid in the sense that scores on them change as the person grows in experience, wisdom, ability to perfrom effectively on various tasks that life presents to him." Such measurement of learning characteristics is essential for effective instruction (11) and to predict the success of students in a multiple learning system stressing individual instruction. By assessing the changing state of the learner through edumetric means, data is gathered than can maximize the use and allocation of instructional methods and resources. The edumetric approach is not designed to show the relationship of an individual to a norm group or population nor is it necessarily designed to show an individual's standing in relation to some hypothetical variable or standard. The edumetric approach can support generalizations about an individual's performance relative to a domain of tasks (6) and is ideally suited for instructional systems that attempt to be adaptive to individuals (11).

Reliability

The reliability or consistency of a psychometric test is dependent upon variance. When there is no variance and all the individuals taking the test score about the same, then it can be stated that the test is not reliable in a psychometric sense. When the test can repeatedly discriminate between individuals from one testing administration to the next, then the test is considered to be reliable. Consistency also plays a role in edumetric reliability but not in the same sense as in psychometric testing. Instead of discriminating between individuals, edumetric reliability is concerned with the consistency of gain or growth by an individual as reflected in the test (3). The reliability of an edumetric test is not dependent upon variance but upon the consistency of gain or growth in scores within an individual on two occasions. The reliability of the edumetric test can be estimated by administering alternate forms of the test on two occasions or by administering alternate forms under equal treatment conditions and then determine the consistency of gain or change made by the individual on the different forms.

Validity

The validity of a psychometric test is determined when individual differences on a test are compared to individual differences on another variable that is assumed to be highly related to the test (3,5). When the test discriminates among those taking it in about the same way as the variable, then there is positive evidence that the test is valid. The validity of the test can be realized through a single administration of the test at one point in time. The validity of an edumetric test can be realized only through the

administration of the test at two points in time (i.e., a pre-test and post-test). The validity of an edumetric test is determined when an individual's gains in a test are compared to his gains or expected gains in skill development.

In summary, psychometric reliability involves the consistency of a test to show the relationship of an individual to a relevent group or population on one occasion. Edumetric reliability involves the consistency of a test to show the amount of gain or change within an individual on two different occasions (1). Psychometric validity involves the correlation between individual differences and group differences while edumetric validity involves the degree of sensitivity of a test to measure the change or gain of an individual (1).

Course Descriptions

The above considerations were relevent for two classes taught at Northeast Missouri State University - LL 170 Speech Communication and SS 120-121 World Civilizations. Since both classes are constructed along the lines of individualized instruction and utilize CSM, it became important to establish the edumetric reliability and validity of the procedures used in the classes.

Both classes take into account that individual students vary in the learning strengths they bring to a particular course. If a course uses only one or two instructional methods, those students who have learning strengths in dissonance with the course's method of instruction, will learn less than they could. If a course is structured so that various learning methods and materials can be matched to the students' individual learning strengths, the

students' learning and affective responses will be enhanced positively. To achieve the latter, both classes follow this procedure: the optimal learning style(s) of the student is determined through the use of the CSM and through empirical mapping; various learning modes are then matched to the student's learning styles. The availability of several learning options increases the chances of effective, efficient, and accountable competency based learning on the part of the student.

Specifically, the courses involve the following steps: pre-testing of individual students' current knowledge and skill levels; determination of learning needed; identification of relevant objectives; CSM conference describing learning strengths, optimal styles for the course and recommended learning modes; individual students' learning; optional self-check tests; testing of identified knowledge and skill objectives; testing of terminal synthesis and use skills; and observable competencies. There are slight modifications of this model for the two courses partly due to the nature of the two disciplines.

METHOD

Data Collection

Data was collected during the Fall semester, 1974, at Northeast Missouri State University in LL 170 Speech Communication and SS 120-121 World Civilization. Subjects with complete data were included in the study. This involved 51 from LL 170 and 20 from SS 120-121. The data from the latter group was complete except for the skill test area. Over 70 percent of the subjects were freshmen and over 80 percent of the remaining subjects were

sophomores. The CSM pre-test was given the first week of the semester and the post-test was given the last week of the semester or after people had completed the course. The skill tests were given during the semester both before and after the relevant skill area. Specifically the gain scores were computed by subtracting the pre-test scores from the post-test socres for the CSM items, element totals, and skill tests.

Instruments

The CSM instrument was modified to adapt to the Northeast Missouri State University student. Those items which appeared to be oriented toward the older ages of community college students or urban living were changed in content to relate to late teenagers or rural living. For example, Item 19A "I enjoy taking children to a zoo or library" was changed to "I enjoy taking children to a fair." The Speech Communication skill tests were competency-based power tests with the criterion of 100% attainment of objectives. For example, T(AL) was tested by each student listening to a five-minute video-taped message without taking notes and then correctly answering all of the following: the communicator's purpose, three main points, and five factual or inferential questions about the message. The nature of the skill tests was behavioral and paper-pencil tests. The reliability and validity of the skill tests have been shown through a variety of means including a comparison with commercially-prepared instruments.

Reliability

The concept of domain sampling and the method of inter-correlations among the items were employed (9). Reliability was computed using the Kuder-

Richardson-20 formula (9, 2), the split-half correlation approach (7, 458), and the standard error of measurement (9, 10-11). The KR-20 and the split-half reliability coefficients were considered measures of internal consistency. That is, as the intercorrelations from the items increase, the odd-even totals will approach each other and in the extreme case of the intercorrelations being +1.00 the odd-even halves would be correlated +1.00. Split-half reliability was computed by determining the chronology of the eight items for each element as they appeared in the instrument. Then the odd times and the even items were summed and correlated. The Spearman-Brown Formula was used to determine the odd-even reliability coefficient for the whole element.

Validity

The concept of domain sampling was used. Also the criterion skill tests were created independently from the CSM items and elements and both were reliable (10,2). Internal validity was computed by correlating the item gain scores with the element total gain scores. In addition the correlation averaging procedure (7, 463) was used for estimating the internal validity of the element total. Edumetric external validity was computed by the correlation with concurrent skill test gains. Correlations of the element total gain scores were correlated with the percentage improvements in the skill tests.

Estimated Reliability and Validity

As described earlier the range of ages and educational levels of the subjects was small. The standard deviations of the element totals was also relatively small. The average standard deviation was equal to 4.833 which

involved 15.103 percentiles of the total range. Accordingly an estimated reliability figure was computed for the larger population using the narrow range-wide range procedures described by Hill (9, 13-15). It was assumed that the wide range standard deviation of the entire population for all post-high school people would be at least twice as large as the standard deviation for the subjects studied. After the estimate edumetric reliability was computed for a doulbed standard deviation, the estimated edumetric validity was determined by the relationship, the square of the reliability coefficient was equal to or greater than the validity coefficient.

RESULTS

Table 1 indicates the means and standard deviations of the gain score means for the CSM items and element totals and Table 4 indicates the skill test gain score means and standard deviations in terms of percentages. The following average CSM gains (n=71) in percentiles were recorded during the semester: Symbolic Orientations-Theoretical, 4.864; Symbolic Orientation-Sensory, 5.906; Symbolic Orientations-Programmatic, 6.866; Symbolic Orientations-Cultural Codes, 4.861; Cultural Determinants, 1.292; and Modalities of Inference, 4.394. Also, 83.8% of the CSM item gain scores were of the same sign as the CSM total. 26 of the 27 CSM element totals increased with A (Associates) being the only exception.

Table 2 indicates the three measures of edumetric reliability. A correlation of .235 (DF=69) is significant at the $p = .05$ level and a correlation of .304 (DF=69) is significant at the $p = .01$ level. Accordingly 20 of

of the 27 KR-20 edumetric reliability coefficients were significant at the .05 level and 18 of the 27 were significant at the .01 level. 22 of the 27 split-half edumetric reliability coefficients were significant at the .05 level and 20 were significant at the .01 level.

Table 3 indicates the edumetric internal validity results. Over 96% [redacted]e items had "acceptable" item internal validities above .20 (8, 7). Over 94% of the CSM items had edumetric internal validity coefficients significant at the .05 level and over 81% at the .01 level. All element edumetric internal validity coefficients were significant at the .01 level.

Table 4 indicates the concurrent edumetric external validity coefficients for the five elements sutdied in the Speech Communication classes. Two of the five edumetric external validity coefficients were significant at the .05 level. Table 5 reflects the estimated edumetric reliability and validity coefficients for the larger population. All estimated reliability and validity coefficients were significant at the .01 level.

DISCUSSION

The study described the differences between edumetric and psycho-metric uses of tests and clarified the relevance of the edumetric dimension for measuring student learning gains, especially in the context of individualized instruction involving multiple learning mode options. Also, the procedures for edumetric reliability and validation assesssment were described. The procedures were applied to two described classes, Speech Communication and World Civilizations. The results yielded strong evidence for the edumetric reliability and validity. Extremely strong evidence was provided by the

reliability and validity coefficients estimated for the entire population.

IMPLICATIONS

This study is part of the ongoing program of reliability and validity assessment of the CSM items and elements. Specifically this study investiaged edumetric reliability and internal and external validity. The results of this study corroborate other experimental and empirical validation studies. Several areas for further study are pertinent. Of major concern is the determination of the acutal wide range standard deviation for the post-high school population. Second, the results of this and similar studies of edumetric validity and reliability at other locations would enable the identification and improvement of less strong CSM items. Third, these edumetric reliability and validity procedures can supplement the psychometric reliability and validity procedures. Fourth, the edumetric reliability and validity procedures could be applied to other tests; for example, the CSM instrument for high school students. A fifth implication would involve predictive validity. In this context CSM element and test gains could be used to predict student learning gains and student learning gains could be used to predict CSM elements and test gains. Finally, pre-test post-test CSM gains could be used for the assessment of learning gains resulting from courses.

In summary, evidence has been provided for the edumetric reliability and validity of CSM and various fruitful implications for further study have been considered.

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Table 1.-Means and Standard Deviations for Cognitive Style Mapping Gain Scores

Element		1	2	3	4	5	6	7	8	Total
T(AL)	$\bar{X}$	.0563	-.1127	.2254	.1408	.0563	.1972	.0000	-.2817	.4225
	SD	1.3415	1.4197	1.7619	1.1784	1.4621	1.6836	1.6784	1.7213	5.1229
T(AQ)	$\bar{X}$	.2817	.5352	.1408	.2817	.2817	.2817	.0845	.3662	2.3380
	SD	1.4745	1.2982	1.3140	1.5122	1.4745	1.3550	1.2754	1.7860	4.6023
T(VL)	$\bar{X}$	.0563	.1690	.3944	.2254	.2817	-.0845	.3662	.3099	1.8028
	SD	1.1614	1.4141	1.7641	1.1408	1.3960	1.5175	1.6206	1.4495	4.9579
T(VQ)	$\bar{X}$	.2254	.1690	.2817	.2254	.2254	-.3099	.0845	.5070	1.6620
	SD	1.5216	1.2245	1.3960	1.1891	1.5582	1.5618	1.5175	1.5279	3.2887
Q(A)	$\bar{X}$	-.1408	.5634	.0000	.3099	.4225	.5070	-.3944	.1972	1.5211
	SD	1.4756	1.1225	1.4241	1.1938	1.2063	1.3725	1.4868	1.1703	4.1175
Q(O)	$\bar{X}$	.1972	.8451	.6479	.3099	.7887	.3380	.1690	.2254	3.5493
	SD	1.3068	1.6670	1.5664	1.1938	1.6944	1.5377	1.3737	1.1408	5.2347
Q(S)	$\bar{X}$	.5634	.1127	.0282	.2535	.0563	.1690	.3099	.2958	2.4225
	SD	1.3504	1.4588	1.2779	1.3397	1.2988	1.0479	1.1938	1.8644	5.2881
Q(T)	$\bar{X}$	.1127	.0845	.3380	.3099	.1972	.1972	.0563	.0563	1.3803
	SD	.6618	.9154	1.5739	1.2847	1.1211	1.4303	1.1119	1.2988	4.4099
Q(V)	$\bar{X}$	.1690	.3380	.1127	.4225	.0563	-.0282	.0282	-.2817	.6197
	SD	1.4141	1.4236	1.2050	1.2964	1.7107	1.4435	1.3632	1.4745	4.6584
Q(P)	$\bar{X}$	.1408	.4507	.1690	.1127	.6197	-.0282	.3380	.3662	2.1772
	SD	1.1296	1.5454	1.0479	1.4588	1.3673	1.3212	1.2553	1.5128	4.8596
Q(CEM)	$\bar{X}$	.0000	.3380	.0000	.0845	.1972	.2535	.3380	.0563	1.3521
	SD	1.3001	1.3834	1.5382	.7827	1.1703	1.1594	1.3421	1.2547	4.6606
Q(CES)	$\bar{X}$	.1408	.3099	.2817	.1690	.2817	.3099	.2535	.0563	1.7465
	SD	1.0785	1.3696	1.3550	.8719	1.1770	1.0953	1.3811	1.4621	5.1010
Q(CET)	$\bar{X}$	.2817	.3380	.2254	.3662	.2254	.1408	.0563	-.0704	1.4085
	SD	1.6546	1.2994	1.3655	1.3966	1.2356	.8441	1.0600	1.1906	4.6560
Q(CH)	$\bar{X}$	.0845	.2535	.1127	.2817	.3099	-.0282	.1972	.3521	1.6620
	SD	1.5542	1.3397	1.6059	1.3960	1.1456	1.2779	1.6498	1.5931	6.1345
Q(CK)	$\bar{X}$	-.0845	-.0141	.2394	.4789	.0563	.3380	.1127	.4789	1.3803
	SD	1.1838	1.2615	1.3683	1.2317	1.4621	1.2096	1.4588	1.3621	4.6825
Q(CKH)	$\bar{X}$	.3662	.2817	.0282	.0845	.1408	-.0845	.2535	-.1972	.9577
	SD	1.4363	1.1770	1.2330	1.4799	1.3562	1.3609	1.4604	1.5800	5.1770
Q(CP)	$\bar{X}$	.1690	.1690	.4225	-.1690	.0000	.1408	.2535	.4789	1.4085
	SD	1.1004	1.2890	1.7735	1.5653	1.3840	1.0250	1.4213	1.5910	4.4834

Table 1.-Means and Standard Deviations for Cognitive Style Mapping Gain Scores, cont.

Element		1	2	3	4	5	6	7	8	Total
Q(CS)	$\bar{X}$	.3380	.4507	.1408	.4789	-.0282	.1972	.3662	.3380	2.1127
	SD	1.0062	1.3509	1.3140	1.2767	1.3632	1.2175	1.3966	1.2553	4.9435
Q(CT)	$\bar{X}$	.4507	.6761	.2254	-.2535	-.0282	.1408	.0000	.4225	1.9718
	SD	1.1723	1.1601	1.4062	1.0031	1.3212	1.3140	1.2560	1.3806	4.7766
A	$\bar{X}$	-.3944	-.1127	.1408	.0282	.0845	-.2535	.0845	-.1127	-.4507
	SD	1.5608	1.4197	1.3140	1.4039	1.6930	1.3397	1.3188	1.4197	4.2220
F	$\bar{X}$	-.1408	.0845	.1972	.1127	-.1127	-.1127	.2113	-.0423	.1972
	SD	1.3971	1.5175	1.1703	1.5704	1.4197	1.3380	1.4134	1.2609	4.0302
I	$\bar{X}$	.3662	.1690	.1972	.2254	.0563	.3662	.3944	-.1127	1.4930
	SD	1.3556	1.3737	1.3068	1.3655	1.4621	1.1777	1.3256	.9427	3.8816
M	$\bar{X}$	.0282	.1408	.1972	.3944	.1972	.3944	.6197	-.0563	2.4507
	SD	1.5562	1.4756	1.7811	1.5243	1.2629	1.3266	1.6981	1.5372	7.3863
D	$\bar{X}$	-.2535	.1690	.0845	-.0845	.0563	.1268	.0282	.1127	.1408
	SD	1.3397	1.6009	1.5175	1.0844	1.2547	1.5916	1.2330	1.3794	5.0610
R	$\bar{X}$	.0845	.5352	.1690	-.1972	-.0845	.3662	.1127	-.1408	1.0896
	SD	1.4413	1.6769	1.5289	1.1211	1.0844	1.3766	1.4969	1.4756	4.3221
L	$\bar{X}$	.0000	.2535	.1690	.2254	.4789	.2817	.1408	.0563	1.8169
	SD	1.3427	1.3397	1.4534	1.4842	1.3200	1.3550	1.3971	1.2547	4.9027
(K)	$\bar{X}$	.6479	-.1690	.0845	.1408	.4225	.2254	.2535	-.1127	1.5211
	SD	1.4927	1.6698	1.3609	1.2704	1.4208	1.3655	1.3397	1.4588	4.5218

Table 2.-Three Measures of Edumetric Reliability for Cognitive Style Mapping Elements

Element	Kuder-Richardson-20 Reliability Coefficient	Split-Half Reliability Coefficient	Standard Error of Measurement
T(AL)	.313	.274	4.2459
T(AQ)	.242	.347	4.0068
T(VL)	.363	.305	3.9505
T(VQ)	.624	.184	1.8486
Q(A)	.211	.028	3.6572
Q(O)	.442	.372	3.9103
Q(S)	.708	.383	3.4553
Q(T)	.459	.624	3.2435
Q(V)	.289	.339	3.9308
Q(P)	.447	.338	3.6099
Q(CEM)	.376	.339	3.6818
Q(CES)	.560	.629	3.3835
Q(CET)	.447	.327	3.4622
Q(CH)	.629	.699	3.7355
Q(CK)	.415	.521	3.5816
Q(CKH)	.482	.477	3.7259
Q(CP)	.234	.434	3.9239
Q(CS)	.533	.718	3.3784
Q(CT)	.510	.588	3.3436
A	.082	.051	4.0451
F	.054	.286	3.9198
I	.121	.374	3.6600
M	.752	.646	3.6784
D	.458	.355	3.7259
R	.162	.213	3.9565
L	.429	.516	3.7049
(K)	.233	.167	3.9602

Table 3.-Edumetric Internal Validity for Cognitive Style Mapping Items and Elements

Elements	Item 1	2	3	4	5	6	7	8	Element
T(AL)	.3408	.4946	.4139	.3728	.2977	.3757	.4325	.2946	.571
T(AQ)	.3679	.2715	.5977	.4639	.3928	.3732	.4366	.3482	.613
T(VL)	.3835	.2860	.3567	.4661	.4883	.4920	.5138	.4475	.644
T(VQ)	.2863	.2215	.4134	.1777	.3980	.0759	.2586	.2997	.379
Q(A)	.2485	.4119	.3363	.4543	.2903	.6112	.4201	.0196	.527
Q(O)	.5401	.4633	.4960	.3379	.4974	.3689	.5797	.3661	.677
Q(S)	.5028	.3387	.2159	.1545	.2799	.3140	.2678	.4074	.459
Q(T)	.5837	.5154	.5659	.4913	.3552	.5017	.3174	.3700	.685
Q(V)	.4374	.2573	.5596	.4791	.2643	.3545	.3810	.5667	.618
Q(P)	.3853	.4612	.4807	.3548	.3296	.5806	.4421	.5195	.663
Q(CEM)	.4370	.5582	.4715	.1849	.4056	.5671	.6475	.4494	.688
Q(CES)	.5185	.4306	.4423	.4403	.6312	.5485	.4249	.6364	.737
Q(CET)	.5189	.4335	.3754	.5532	.3561	.4942	.3835	.4041	.657
Q(CH)	.6116	.4217	.5815	.4124	.4558	.4156	.5744	.5166	.726
Q(CK)	.3564	.2751	.5507	.3738	.4824	.5244	.4308	.5235	.657
Q(CKH)	.3014	.0482	.4282	.5336	.5986	.3633	.6013	3714	.612
Q(CP)	.2601	.4657	.2865	.3149	.3904	.2878	.4479	.6163	.580
Q(CS)	.3208	.4311	.5960	.4914	.5857	.3614	.6305	.4659	.711
Q(CT)	.2538	.1966	.6803	.3072	.6515	.4405	.6292	.4717	.675
A	.3920	.3957	.3263	.4679	.3837	.1790	.2598	.3393	.516
F	.4152	.3934	.2307	.3347	.2796	.4534	.4279	.3675	.548
I	.3458	.2908	.3751	.4042	.3922	.3610	.3123	.4001	.544
M	.4988	.3767	.3444	.5397	.2562	.5511	.4853	.3992	.646
D	.2628	.4838	.4166	.3101	.5577	.5608	.5049	.4738	.665
R	.2202	.4630	.2447	.3005	.3804	.4187	.3379	.4041	.521
L	.4964	.5817	.5183	.3270	.3269	.3258	.5260	.4321	.660
(K)	.4967	.5340	.5376	.3942	.2683	.2821	.3920	.2480	.595

Table 4.-Edumetric External Validity for Selected Cognitive Style Mapping Elements

Element	Element Gain Scores		Skill Gain Scores(%)		Validity Coefficient
	Mean	Standard Deviation	Mean	Standard Deviation	
T(AL)	.4225	5.1229	45.3462	20.8169	.1736
Q(A)	1.5211	4.1175	64.9038	40.2694	.3071
Q(CK)	1.3803	4.6825	52.1154	13.3570	.3353
Q(CP)	1.4085	4.4834	36.4808	25.2857	.1150
Q(CS)	2.1127	4.9435	86.8077	26.2862	.2583

Table 5.-Estimated Edumetric Reliability and Validity for Cognitive Style Mapping Elements

Element	Estimated Reliability Coefficient	Estimated Validity Coefficient
T(AL)	.828	.686
T(AQ)	.811	.658
T(VL)	.841	.707
T(VQ)	.906	.821
Q(A)	.803	.645
Q(O)	.861	.741
Q(S)	.927	.859
Q(T)	.865	.748
Q(V)	.822	.676
Q(P)	.862	.743
Q(CEM)	.844	.712
Q(CES)	890	.792
Q(CET)	.862	.743
Q(CH)	.907	.823
Q(CK)	.854	.729
Q(CKH)	.871	.759
Q(CP)	.809	.654
Q(CS)	.883	.780
Q(CS)	.878	.771
A	.771	.594
F	.764	.584
I	.780	.608
M	.938	.880
D	.865	.748
R	.791	.626
L	.857	.734
(K)	.808	.653